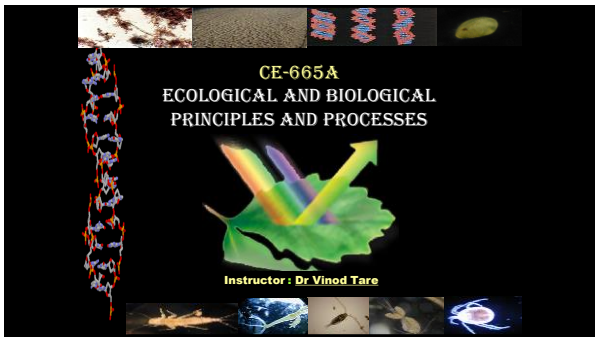
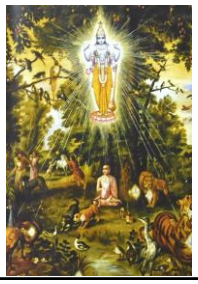


Environment → Ecology and Biology



सर्वस्य चाहं हृदि सन्निविष्टो, मत्तः स्मृतिर्ज्ञानमपोहनं च।
वेदैश्च सर्वैरहमेव वेद्यो, वेदान्तकृद्वेदविदेव चाहम्।।

God is seated in everyone's heart, And from Him comes remembrance, knowledge and forgetfulness.

God is known by all Vedas, Indeed He is the compiler of Vedanta, and He is the knower of Vedas

- Ecology → Biology++ → (Chemistry + Physics) ++
- **Mathematics, Statistics & Probability**

Course Outline

- Section I: Ecology
- Section II: Biochemistry
- Section III: Microbiology
- Section IV: Applications – Water Treatment/Waste (Residue) Processing/Recycling

Grading Policy

- Quizzes (Ten as per schedule): 20 % Weightage
- Mid Semester Examination: 30 % Weightage
- End Semester Examination: 50 % Weightage

Course Material

Course Website

- **Visit regularly for**
  - Schedule of Virtual Lectures
  - Announcements
  - Quiz/Exam Schedules
  - Lecture presentations
  - Course notes
  - Reference materials

References

Reading Material (PPT, Notes and Reference Material)

Study Questions

Section I: Ecology

- Botkin, D B and Keller, E A (1987) *Environmental Studies – Earth as a Living Planet*, 2nd Ed, Merril Publishing Company, Columbus, OH, USA.
- Turk J and Turk A (1988) *Environmental Science*, 4th Ed, Saunders College Publishing, Philadelphia, PA, USA.
- Caughley, G and Sinclair, A R E (1994) *Wildlife Ecology and Management*, Blackwell Scientific Publications, Boston, USA

References

Section II & III: Biochemistry & Microbiology

- Pelzar, M J Jr, Chan, E C S and Krieg N R (1993) *Microbiology – Concepts and Applications*, McGraw Hill Inc, New York, USA.

Section IV: Applications – Water Treatment/Waste (Residue) Processing/Recycling

- Weber, W J (2001) *Environmental Systems and Processes –Principles, Modeling and Design*, Wiley-Interscience, New York, USA.
- Benefield, L D and Randall, C W (1980) *Biological Processes Design for Wastewater Treatment*, Prentice Hall Inc, New Jersey, USA.
- Metcalf & Eddy, Inc. and Techobanoglous, G (1979) *Wastewater Engineering: Treatment, Disposal, Reuse*, McGraw Hill, New York, USA.

Students Transformation at IIT Kanpur

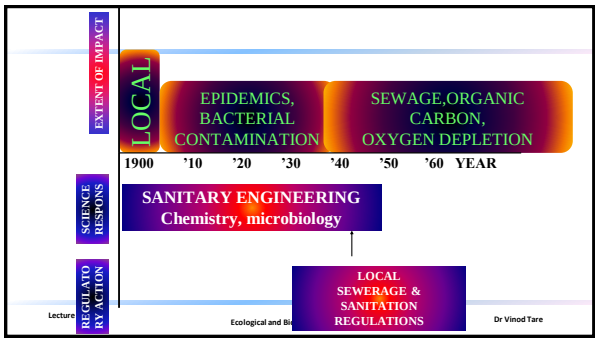
Success & Failure

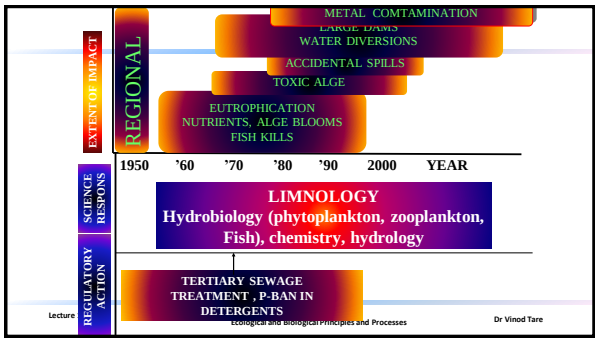
"Success is the ability to go from one failure to another with no loss of enthusiasm"

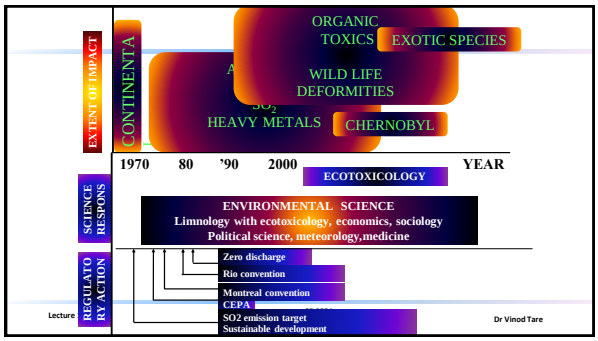
-Sir Winston Churchil

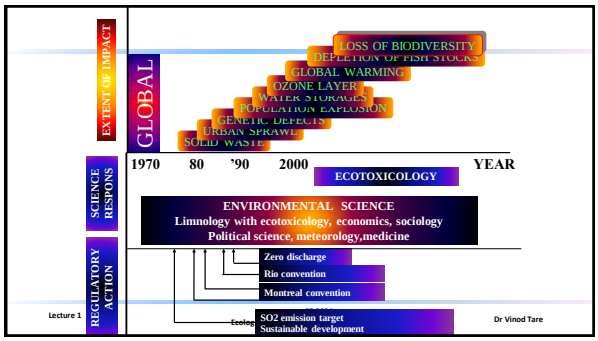
Explosion of Environmental Issues

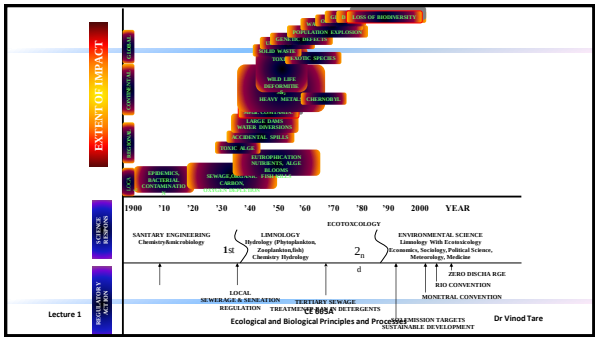
- From Few to Many, From Local to Global
- Science Response
- Response of Regulatory Agencies







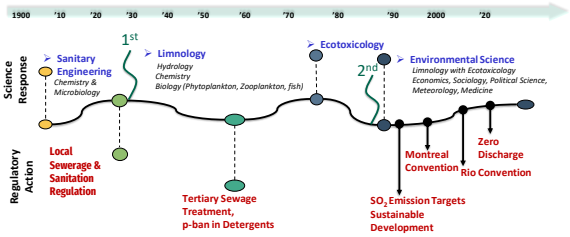




Explosion of Environmental Issues

- From Few to Many, From Local to Global
- Science Response
- Response of Regulatory Agencies

Scientific and Regulatory Response to Environmental Issues



Emergence of Environmental Science/ Engineering/ Management Discipline

- **Public Health Engineering**
  - Water Supply ⇨ Civil Engineering
- **Sanitary Engineering**
  - Water Supply and Sanitation ⇨ Civil Engineering
- **Environmental Engineering and Management**
  - Inter Disciplinary Infra-structural Engineering

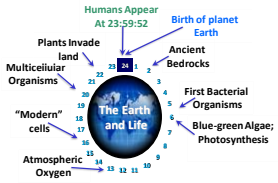
Environmental Science/Engineering/ Management Discipline

- **Multidisciplinary or Interdisciplinary**
  - Various disciplines of Science or Engineering or Management
- **Several Professions and Sectors**
  - Industry, Business, Academics and Research, Policy Making, Planning, Judiciary, Implementation/Administration, Journalism; Government/Semi government or Public/ Private Sector/NGOs
- **Preventive Activities, Control Activities, Remedial Activities ⇨ Resource Conservation, Sustainable Development; "End of the Pipe" Solutions; Regeneration**

Environmental Engineering and Management Programme

- **CE 602: Mathematics**
  - Basic Preparatory Course
- **CE 664: Physicochemical Principles and Processes**
  - Fundamental Aspects of Physical, Chemical and Physicochemical Processes
- **CE 665: Ecological and Biological Principles and Processes**
  - Fundamentals Aspects of Ecological and Biological Processes/Systems
- **CE 666: Air Pollution and Its Control**

Evolution of Our Planet



Earth is estimated to be **4.54 billion years old**, plus or minus about 50 million years

Our Planet

- Planet Earth from above – No Borders, No Walls, or no Passport Control
  - Just a magic blue and white pearl where all life exists
  - All people are the Citizens of the world
  - All people are dependent on each other, rather all forms of life is dependent on each other.

Our Planet

"Planet Earth – is a Giant Self-Regulating System"

- Gaia Hypothesis

Our Planet

Fascinating Aspects:

- The existence of Ozone Layer in the upper atmosphere, crucial for sheltering living organisms from the harmful UV radiations
- Stabilization of the proportion of oxygen at approximately 21%, balanced through production and decomposition of organic matter
- Presence of small, but essential, quantities of ammonia in the atmosphere enabling the neutralization of naturally produced sulphur and nitric acid
- The relatively constant air surface temperature in spite of changes in the gaseous composition of the atmosphere and solar radiation, and
- The constancy of the salt content in the oceans at 3- 4 %, even through minerals are constantly added via rivers.

Our Planet

"The other important aspect of a Self-Regulating Capacity of our planet is the ability of living systems on Earth to counteract changes in the external environmental through uptake, metabolism and excretion of substances."

Comparison between Planetary and Human Body

Day & Night	→	***Heart Beats***
Seasons	→	***Breaths***
Tropical Rain Forests	→	***Liver***
Atmosphere & Oceans	→	***Circulatory Systems***

Natural Changes V/S Anthropogenic Influences

"Changes have been taking place" why are we concerned now, and "what is the role of human beings, because they appeared very late"

- Human development has caused wide spread environmental interventions. The effects of technological endeavors have in some cases to fast to control

- **Result:** Degradation of the world's environmental resources which threatens the welfare of the whole planet.

Environmental Degradation

On a Global Scale

- Thousands of tones of topsoil lost every second
- 3000 m square of forests destroyed every second
- 2000 m square of arable land turned into deserts every second, and
- More than 100 species of plants/animals exterminated every day

Environmental Degradation

On a Global Scale

On other hand

"1000 tones of unwanted gases and perhaps another tones of wastes released per second"

This is for what?

"to disproportionately sustain the material wealth of a billion people and barely more than physical survival of the remaining seven billion"

Environmental Degradation

On Our Planet – On a Global Scale

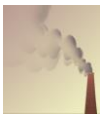
- Developed countries 10% population consumes 10 times more energy, water, and mineral than the rest 90%.
- Under the political and economic conditions of the present global debt crisis, it seems nearly impossible for people in developing countries not to put pressure on nature in order to keep the flow of resources going from South to North.
- If the consumption patterns and the rate associated remain unchanged, reaching the development objectives would mean a roughly five folds increase in the rates of environmental degradation.

Developmental Phases

- Industrial Development
- Environmental Problems
- Environmental Protection

Developmental Phases – Environmental Impacts

- **1800 – 1900 Industrial Revolution**
  - Few, Mainly Local Negative Effects
  - Insignificant Compared with Increase in Material Growth & Simultaneous Environmental Improvements



Developmental Phases – Environmental Impacts

- **1900 – 1950**
  - Deterioration More Extensive
  - Conflict between Economic Growth and Environment
- **1950 – Local, Regional and Global**
  - Negative Environmental Implications
  - Negative Effects >> Benefits of growing Material Wealth
  - Negative Effects ↑ Even when Economic Growth Rate ↓

Terms ……..

Environment

Systems

Environmental Systems

Eco Systems

Environment

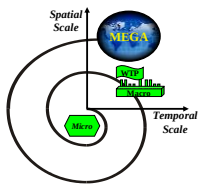
Aggregate of surrounding things, conditions or influences, especially as affecting or that affects the existence or development of someone or something

[LIVING (*Biotic*)] or [NON-LIVING (*Abiotic*)]

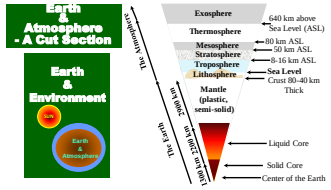
Hardware/ Software ⇨ Physical/Nonphysical

Environment

A continuum of systems involving similar processes over a remarkable range of temporal and spatial scales.



Earth and Atmosphere



Approach to Understanding and Explaining the Environment

Environment is Complex

However, complexity relates more to innate scales and dimensions than to inherent concepts and principles

This premise serving as incentive, approach to understanding and explaining the environment and its myriad systems and processes is to:

- clearly enunciate concepts and related principles.
- initiate analyses on scales at which the principles can be classified and applied rigorously.
- use simple but accurate experimental and mathematical models to articulate those principles, and.
- structure more elaborate models to integrate all relevant principles and thus facilitate their extension to the scale of any system or process of interest.

Important Proverb

"To give a man a fish will feed him for a day, but to train him to fish will feed him for a lifetime"

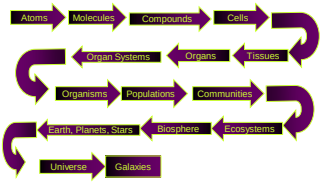
In the same spirit, any one can solve a problem if given the correct algorithm, but it is the knowledge of how to use concepts and principles to construct correct algorithms that enables one to solve any problem

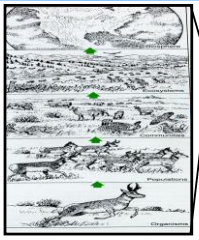
Systems

Collection of objects bonded together in some way so that the collection is more than an independent assemblage of parts

Micro → Macro → Mega Levels (Depending Upon the Boundaries Chosen in a Particular Context)

Micro to Mega Systems





- Galaxies
- Universe
- Earth, Planets, Stars
- Biosphere
- Ecosystems
- Communities
- Populations
- Organisms
- Organ Systems
- Organs
- Tissues
- Cells
- Compounds
- Molecules
- Atomic

Understanding of Changes in Systems

- An understanding of changes in systems is primary in many problems in environmental studies.
- In some cases, very small growth rates may yield incredibly large numbers in modest periods of time.
- It may be possible to compute an average residence time for a particular resource and use this information to develop sound management principles.
- Recognition of positive and negative feedback in systems, and calculation of growth rates and residence times, enable predictions concerning resource management.
- It is important to understand the ways in which physical and biological processes, with or without human interference, may modify ecosystems and Earth.

Systems

- Systems may be open or closed. A system that is open in regard to some factor exchanges that factor with other systems. A system that is closed in regard to some factor does not exchange that factor with other systems.
- Systems respond to inputs and have outputs. Our body, for example, is a complex system. If we see a snake in this classroom, the sight of the snake is an input. Our body reacts to that input – the adrenalin level in our blood goes up, our heart rate increases, and so on. Our response, perhaps moving away or arresting/killing the snake – is an output.

Changes in the System

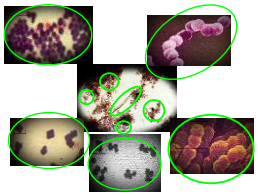
- Changes in natural systems may or may not be predictable, but anyone looking for solutions to environmental problems should be recognized such changes.
- By using rates of change or input/output analysis of systems, we can derive an average residence time for such factors. The average residence time is a measure of the time it takes for the total stock or supply of a particular material, such as a resource, to be cycled through the pool.

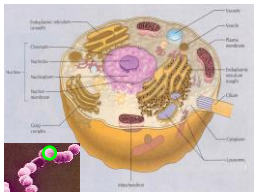
Understanding Systems

- Solutions to environmental problems often involve an understanding of systems and rates of change.
- A system is a set of components or parts functioning together to act as a whole.
- In environmental studies, at every level, one deals with complex systems; thus, it is important to understand certain basic characteristics of every system. A single organism is a system. A sewage treatment plant is a system. A city can be a system. Earth is a system.

Environmental Systems - Analysis Approach

- All systems are comprised by subsystems; mega-scale systems by macro-scale systems, and macro-scale systems by micro-scale systems. This is why many processes can be influenced at the macroscopic scale by similar microscopic mass transfer phenomenon.
- The most fundamental analysis of any system has its origins ultimately at the molecular level and must provide that there is a continuity of principles derived from this scale to the full scale of the system.





Life on the Planet Earth

- Earth as a planet has been profoundly altered by life.
- Earth's air, oceans, soils, sedimentary rocks are very different from what they would be on a lifeless planet.
- In some ways, life controls the makeup of the air, oceans, and sediments.
- It has greatly changed Earth's surface during the last 3 billion years and continues to control and modify

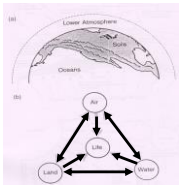
Biosphere

- It is the region of earth where life exists.
- It extends from the depths of ocean to the summit of mountains, but most life exists within a few meters of Earth's surface.
- The biosphere includes all of life, the lower atmosphere, and the oceans, rivers, lakes, soils, and solid sediments that are in active interchange of materials with life.

All living things require energy and materials. In the Biosphere, energy is received from the sun and the interior of Earth, and is used and given off while materials are recycled.

Life & Land-Water-Air Interaction

The Biosphere is a linked system, all its parts are connected



Fundamental Principles: Uniformitarianism

- Earth and its life forms have changed many times, but certain processes necessary to sustain life and a livable environment have occurred throughout much of history.
- The principle that present physical and biological processes that are forming and modifying our Earth can help explain the geologic and evolutionary history of Earth is known as the doctrine of uniformitarianism.
- Simply stated as "the present is the key to the past"
- Uniformitarianism does not demand or even suggest that the magnitude and frequency of natural processes remain constant with time. Obviously, some processes do not extend back through all of geological time.

Fundamental Principles: Uniformitarianism

- To be useful from an environmental standpoint, the doctrine of uniformitarianism will have to be more than a key to the past.
- A study of past and present processes may be key to the future. That is, we can assume that in future the same physical and biological processes will operate, but the rates will vary as the environment is influenced by human activity.

Fundamental Principles: Environmental Unity

Environmental Unity means that it is impossible to do only one thing; that is, everything affects everything else. Many aspects of environment are closely related. Disruptions or changes in one part of the system will often have secondary and tertiary effects within the systems or will even affect adjacent system. Earth and its ecosystems are complex entities in which any action has several or many effects.

End of Lecture 1: Thank You

Questions, Comments & Suggestions may be sent to

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